REPORT AND SPECIFICATION

ACCOMPANYING ONE OF THE PRIZE PLANS FOR THE

SUPPLY OF THE CITY OF HAMILTON WITH WATER FROM BURLINGTON BAY.*

"NON QUO, SED QUOMODO."

[NOTE.—This Report is re-published by a Member of the Provincial Agricultural Association, on account of the great novelty and merit which the plan of Water Distribution, recommended by the Engineer, possesses; and of the professional ability and ingenuity displayed in the preparation of the Plans and Report.]

The Chairman of Fire and Water Committee, City Hall, Hamilton.

The general arrangement of Main, and Sub-main, and Service-pipes, is indicated by blue lines on the accompanying enlarged Map of part of the City of Hamilton. The position of the Distributing Reservoir, Engine-house, Stand-pipe, &c., is also shown thereon; and the height of the water in the Reservoir above the several streets, at their intersections, is given in red figures.

SITUATION AND CONSTRUCTION OF RESERVOIR.

The situation chosen for the Reservoir is on the high ground to the south of the property of Sir Allan McNab; it occupies the entire block bounded by Florence, Governor, Lock, and Princess streets, and is slightly undulating (but in the main nearly level), affording an excellent base for the embankments, and is therefore preferable to a site, the natural surface and underlying straitfication of which deviates in any great degree from an horizontal direction. The reservoir is divided into two compartments by a central embankment, provision being made (as hereafter described) for the thorough cleansing of either compartment without emptying the other, or interfering in any degree with the continuous supply of water. The embankments are proposed to be formed of clay of a retentive quality, an abundance of which can be readily procured in the neighbourhood. The outer slope is at the rate of one and a half to one, and the inner at the rate of two to one; the bottom and inner slope to be lined with hard-burnt clinker bricks, laid on edge, and grouted with hydraulic mortar, and resting upon a bed of concrete one foot thick, the embankment and bottom having been first puddled with

* Re-printed, by permission, from the pamphlet on the subject, originally published by the City Council, January, 1855.

blue clay; injury to the embankment from the percolation of water through its substance will thus be effectually prevented.

Size of Reservoir, &c.

The size of each compartment will be, at the water line, 170 feet long and 150 feet wide; the depth of water will be 21 feet; the height of the water above the average level of the Bay will be 144 feet. The capacity of each compartment will be 2,022,433 gallons; the entire quantity of water in both compartments will be 4,044,866 imperial gallons, or 4,850,338 American gallons, affording a supply for more than four days to 40,000 inhabitants, estimating the quantity to be supplied to each at 30 imperial gallons per day, or 36 standard American gallons.

Supply Pipe, &c.

Each compartment is provided with a separate influent or Supply pipe from the engine, entering the reservoir at the point indicated on the drawings This pipe terminates in a chamber of masonry, arranged in such a way that the current of water therefrom is directed upwards, and is effectually hindered from wasting away or otherwise injuring the bottom of the reservoir, as is frequently the case when, the reservoir being empty, the water is let on from the engine, and when no provision of this kind is made for diverting the force of the current from the bottom; it has also the effect of preventing the current from disturbing any sediment which may happen to be at the bottom of the reservoir, and which would otherwise become mixed with the entire quantity of water therein.

Valves, &c.

This pipe is provided with a hinged Valve, so that when the water is shut off, or the engine ceases to work, the water cannot flow back to the stand-pipe; and thus repairs can be effected upon the valves and stand-pipe without any risk of flooding. Each branch of the supply-pipe is provided with a slide-valve (shown on sheet No. 12), by which connection with the engine can be stopped when necessary. These valves, as well as those of the cleansing-pipes, are enclosed in a valve-house, for greater convenience in reaching them for repairs, or other necessary objects. The apparatus for raising or lowering the slide-valves is placed in the ground floor of this building, so as to be easily within reach of the attendant.

Cleansing Pipes, &c.

The Cleansing Pipes, one from each compartment, also pass through the lower story of this building, and are provided with valves similar to those already described. These pipes communicate with a well, lined with masonry, and sunk below the bottom of the reservoir, which inclines in every direction towards this well. The

cleasing pipes pass from this point through the valve-house to a receiving well, placed outside the building. When it is required to draw off the water entirely from the bottom of one of the compartments, for the purpose of cleansing or repairing them, the valve being opened, the last of all the contents is received in the wells above mentioned, and is drawn away through the cleansing pipe into the receiving well, and passes thence into the main sewer. A man-hole is constructed in the crown of the arch over this well, for the purpose of giving admission thereto, and for removing any silt or mud which may be deposited therein.

Connection Pipe between Compartments, &c.

In order to keep the surfaces of both the divisions at a level, a Connecting Pipe is placed in the central embankment. This pipe is bedded in concrete, and midway a slide-valve is inserted, for opening or shutting the pipe. A circular well or man-hole is constructed at this point, to give access to the valve. A moveable oak frame, supported on stone corbels, projecting from the face of the wall, serves to steady the valve spindle, and to give standing room to the attendant when closing the valve. This framing, as well as the timber covering on the top, can be removed whenever it may be necessary to repair the valve.

Waste Pipes, &c.

When the water has reached its proper height in the reservoir (which is 1 foot 6 inches below the top of the embankment), and still continues to flow from the engine, the surplus water rising in the waste pipes to the bend therein, falls over it into the water-bag in the waste-weir well below, and is thence carried off into the main sewer. At this point the embankment is raised between two retaining walls of masonry, to the height of 4 feet over the pipes, so as to protect them effectually from the frost; and the mouth of these waste pipes is sunk to a depth of 8 feet below the water line, for the same purpose.

Surface Drainage.

A raised terrace, 10 feet wide, is formed round the base of the outer embankment, to protect it at the foot; and on the outer margin of this is constructed an open paved drain, which will receive the superficial drainage of the embankment, and convey it to the sewer, through the necessary gratings and gully drains constructed at each angle.

Delivery from Reservoir, &c.

The delivery from the reservoir is arranged in such a manner that the water may be drawn either from one compartment alone or from both at once, each division having its own separate outlet. The

orifice of each effluent pipe is enlarged to receive a perforated screen of sufficient size to permit the quantity of water necessary for filling the pipe to pass into the main, the screen preventing any grosser matters which may be in the reservoir from passing into the delivery pipes. The effluent pipes pass through a valve-house, similar to that already described, and are united in one principal main of 18 inches diameter, at a little distance. The arrangement of these, as well as the influent and cleansing pipes, is shown in the plan and details of the reservoir, sheet No. 10.

Mode of Distribution, &c.

The mode of distributing the water through the city is shewn in the accompanying enlarged map. The principal main leaves the reservoir on the south side, and passes along Railway-street to its intersection with King-street; thence along the latter to Queen-street; thence, keeping on the high ground in the neighbourhood, on Hunter, Bond, and Anderson streets, to the termination of the latter street, on the east side of the city. From this main, sub-mains proceed down McNab, James, Mary, and Wellington streets, to the north shore of the Lake. At the intersection of the several streets crossed by these sub-mains, service-pipes are attached, by curves of 15 feet radius. Those service-pipes proceed, as shewn on the map, towards the east, in which direction the greater part of the ground on which Hamilton is built inclines. After passing the several intervening blocks, these pipes are again joined to the main, east of that from which they started; and in every case they reach the former at a level very considerably below that of the point whence they first proceeded. The whole of the water is thus made to flow downwards, instead of being forced upwards in the pipes by the pressure of the head. By this arrangement all return currents are avoided, and any sediment there may be remains in a great measure undisturbed. For example, the water leaving the James-street main, by the service-pipe at the corner of King-street, reaches the Mary-street main on the corner of Henry-street, at a level of 36 feet 6 inches below its level in King-street. And again, the junction of the Service-pipe out of the main on Bay-street, at the corner of Cannon and Bay streets, with the main on James-street, is 21 feet below the point at which it leaves the Bay-street main. The great advantage accruing from this mode of distribution is, that it precludes the necessity of having what are technically termed Dead Ends (that is, where the ends of the service-pipes terminate abruptly, without being joined to any other pipe), which not only occasion a heavy and jarring pressure, but are invariably found to be the receptacles of excessive and very prejudicial deposit, which is often both troublesome and expensive to remove. Instead of the

great number of these dead-ends, which the adoption of any other mode of distribution would occasion, there will not be in the whole city any but those at the extreme ends of the main pipes; or, in other words, not more than four or five in all. The system, it is true, is to some extent a novel one, but is in every respect the most suitable and efficient for a city situated as Hamilton is. The circulation of the water is uninterrupted, and its descent continuous from the reservoir to the furthest point to which it is conducted.

Cutting off Connection of Service Pipes, &c.

The manner of cutting off the connection of the Service Pipes with the Mains has also been carefully considered, and is exhibited in Sheet No. 13. It is effected in this way: At the junction of each Service with the Main, a Hydrant or Fire Plug is placed at the nearest side of the street; a Sluice Cock is also inserted in the Service at the same place; at the union of the pipe with the lower Main another Stop-cock is inserted, and on the upper side of this is also an emptying cock bolted to a sleeper cast upon the Service Pipe. When it is desired to isolate any length of the pipe, the upper sluice is closed and the Hydrant opened; the water is thus cut off from the Main; the lower cock is next closed, so that none can enter from the lower Main, and the emptying cock being opened, the water contained in the Service is discharged into the receptacle below, and is thence carried into the Sewer by the small connecting Culvert. As the water leaves the Service Pipe, air is admitted, so that the water flows freely off, and the pipe can then be taken up or repaired as may be necessary. These Sluice Cocks are enclosed in arched wells of masonry, having Man-holes in the crown of the arch, so as to be readily accessible when required.

Cleansing Mains, &c.

The mode of cleansing the Mains from any accumulation in the bottom of such undulations as may necessarily occur in consequence of the unevennes of the ground, is shewn in Sheet No. 13. A cleansing pipe of not less than 6 inches diameter is attached to the Main by a sleeve; this cleansing pipe passes through a man-hole or well, in which is placed a sluice cock, by opening which a quantity of water is rapidly drawn from the Main, carrying with it the silt or mud laying in the pipe, which falls into the water bag in the receiving well and passes thence into the Sewer.

Hydrants, &c.

The form of Hydrant or Fire Plug, as shown in sheet No. 15, possesses many advantages which cannot be claimed for any other with which I am acquainted. In the Drawing referred to is exhibited a vertical section of the Hydrant complete—the cast iron shell is shown

bolted to a branch elbow-pipe; this shell has an internal projecting rim or flange near the top, which is bored to receive the hollow brass plug through which the water finds its way into the hose from the Main. A double-threaded screw, one inch pitch, is cut on a projecting spindle, cast in a piece with the lower end of the plug; and this screw works through a brass cross piece checked into the bottom of the outer shell to act as a nut for the vertical movement of the plug in opening and closing the Hydrant. The water from the main always keeps the space between the exterior of the plug and the interior of the shell full as far up as the bored internal flange of the latter; and when the plug is screwed downwards to its lowest position, as in the Drawing, it escapes into the interior of the plug by the line of slots, and thence up the barrel to the Hose. The stuffing box of the plug being intended to stand excessive pressure, possesses several peculiarities. The gland is cast finished, of composition metal, in which tin forms the chief ingredient; the cupped portion at the bottom of its ring, which fits the plug, slightly overlaps a Gutta Percha Ring with a bottom flange; and in the groove formed by this flange and the bottom edge of the gland, narrow packing ring of Hemp is placed as stuffing, the adjustment being effected by screwing down the three bolts of the gland in the usual manner. The interior of the top of the plug is grooved on each side for the reception of two feathers on the coupling for attaching the Hose; and the upper screw on this coupling is left-handed, so that when the Hose is attached the plug of the Hydrant may be turned to depress it in obtaining a supply of water, without endangering a twisting of the Hose. This Hydrant presents very superior facilities for repair, for it is only necessary to unscrew the four bolts which attach the shell to the Main, when the whole may be lifted out and taken to the workshop, another being put down in its place—the whole operation occupying only a few minutes, and leaving the street undisturbed. The working surfaces are well adapted for durability, and any slight wear cannot effect the tightness of the parts; and the internal pressure in the Mains tends only to close the plug by its action on the screw. Provision is also made for avoiding the effects of frost, as no water remains inside the tubular plug when closed, and as the orifices are passed a short distance above the packing ring, the water in the tube always flows out. The opening screw is of considerable pitch, one turn being sufficient to elevate or depress the plug an inch, and the gradual action of the screw prevents the occurrence of any sudden shock from the rush of water. No stand pipe is required, the communication with the Hose being entirely effected by a short brass tube screwed at each end. For opening and closing, nothing more is required than one of the small lever keys used by the Fire Brigade.

so that no delay can occur from want of proper keys. In point of economy, too, this Hydrant possesses advantages over most others, as where they have been used in England they have been suppled at about £1 sterling each. (This Hydrant has been patented in England, see "Glasgow Mechanics Magazine," vol. 1.)

Pipes.—Size, Strength, &c.

As respects the diameter, thickness, and junctions of the Pipes intended to be used, it may be proper in this place to state, that the sizes of the several Main, Sub-main, and Service Pipes, are marked in figures on the enlarged Map already referred to; and that the thickness of metal of these pipes will be, for

Service Pipes	of 2, 3 and 4	inches.....	¼	inch.
Sub-Main	" 6, 7 and 8	"	½	"
Mains	" 10 and 12	"	⅝	"
Do.	" 15	.....	¾	"

Mode of jointing Pipes, &c.

With regard to the description of joint, it will be seen by reference to sheet No. , that the pipes are shewn with Socket Joints, packed with hemp and leaded, a groove being left in the socket for the lead to run into and thus ensure a perfectly water-tight joint. This method of jointing water-supply pipes has been much practiced, and is no doubt effective when properly done; but it has the disadvantages of greater cost, more trouble in laying, and extreme difficulty of removal should there ever be occasion, as compared with the less expensive, easier laid, and more readily removed and replaced Flange Joint Pipes, packed with Indian Rubber or Gutta Percha packings, and bolted together, as shewn in Sheet No. .

Stand Pipe, Tower, &c.

As in works of this kind it is very desirable to relieve the Engine as soon as possible of the water delivered from the pumps, which is usually effected by the erection of a Stand Pipe, as near to the Engine as may be, and reaching to a height a little over that of the water in the Reservoir, advantage has been taken for this purpose of the high ground immediately adjoining the site of the Engine House, on which it is proposed to erect a Stand Pipe and enclosing Tower, as shewn by drawings on Sheet No. 8. The ground at this point is 83 feet 6 inches above the level of the water in the Bay, the Stand Pipe is 65 feet 6 inches high from the ground level; its total height therefore, about the clacks of the pumps, will be 149 feet, or 5 feet higher than the surface of the water in the Reservoir. At the bottom of the Stand Pipe, leading from the Engine, is fixed a Butterfly or Flap Valve, (also shown in the same Drawing,) the action of which will be to admit the water delivered by every stroke of the pumps to flow up the Stand Pipe, and, at the completion of the

stroke, the Valve closes and prevents its return to the Engine—thus immediatly relieving the pump valves from the pressure of the water.

A Higher Site for the Reservoir, &c.

It may be right here to mention, that although the Reservoir is shown in what to my judgment is, for all present and prospective purposes, the situation best calculated to ensure the completeness and general usefulness of the works, yet that there is another site for the Reservoir (indicated in lines on the enlarged Map), which, if it were deemed preferable to adopt, would secure an additional distributing elevation of 48 feet over the present site. And this change can be made without affecting in any degree the plan and arrangements laid down, further than that the Engines and pumping apparatus would be placed at the foot of Hess or Queen street; the power of the Engines would have to be proportionately increased; and the leading Main be carried down James street, and thence as already shown. This Reservoir would be sunk 10 feet below the ground level, and the embankments formed of the soil removed from the excavation. The arrangement of influent and effluent pipes would be similar to that already discribed, with the exception only of the effluent pipes, which would be made to pass through the same Valve House as the other pipes; and this Valve House would be situated on the North side of the Reservoir.

Engines, &c.

The Engines herein set forth are two double-acting condensing Engines, having a Beam supported on two longitudinal Girders and Columns for each. They are worked upon the High pressure expansion principle—that is to say, admitting the steam at a pressure of 30 lbs. per square inch on the piston, and cutting off the same at an early period of the stroke; thus working at a high degree of expansion, and consequently greatly diminishing the weight and magnitude of the working parts of the Engine; in addition to these advantages, the one and all-important advantage is the saving of wood or coal, which is only to be effected by Engines on this principle. I do not say principle in form, but principle in theoretical construction, based upon practice and observation. The Engine is upon the rotative system, which perhaps to some may appear not so well adapted as the single-acting or Cornish Engine. The Cornish Engine is a very effective one, as it performs its work at a single stroke of the steam cylinder and pump plunger, but it must be remembered that the speed of the Engine is very slow, and one stroke of the piston is used for lifting the plunger, and for this purpose only the steam is employed —hence the ponderous weight and size of the different parts. And of course this Engine is very much more expensive than the Rotative

expansive double-acting Engine. By reference to the Drawings (Sheets Nos. 1, 2, 3, 4, & 5) and annexed Specification, it will be seen that this Engine will work a double-acting Pump so constructed as to perform work at every stroke of the Engine, although the pump attached to each Engine has but one working barrel. The velocity of the piston in the steam cylinder will be 15 single strokes, or 30 double strokes per minute. giving the pump a velocity of 90 feet per minute, which is but a very ordinary speed, and thoroughly effective. The Engine, with such a pump and speed, will at no period have to contend with sudden resistances, the work and speed of the machinery being perfectly uniform in consequence of the action of the pump. On reference to Drawing No. 3, it will be seen that while the pump piston is delivering the water on one side of the same and through the valve marked "*delivery valve*," the water is flowing through the valve marked "*suction valve*" into the space left *in vacuo* by the ascending and descending strokes of the piston—this is performed at every stroke of the same, so that when the stroke is complete and the return stroke is made, the piston meets with the same amount of resistance that it had in delivering the water on the other side—hence the uniformity of the work to be performed. Each Engine is equal to 35 horse power, and sufficient to accomplish the required amount of work.

Pumps.

The Pump consists of a cylinder truly bored and fitted with valves as shewn in the drawing. This pump will throw 60 gallons at one revolution of the Engine, or 1, 296,000 gallons per day, which is more than is needed, but taking into consideration the waste, the quantity required for manufacturing purposes and fires, it is, I think, only a fair allowance. The total cost of the Engines, Pumps, and Boilers, I estimate at £6,000. The Specification of the Machinery, describing the different parts, is annexed to this Report.

Pipe into the Bay, &c.

The mode in which it is proposed to conduct the water from the Bay to the Suction Well of the Engines, is as follows ; a well will be sunk in the position shewn on the enlarged map, of suitable dimensions, and bricked up in the manner described in the Specification, into which the water will be conducted by a Cast Iron inlet pipe, carried out into the Bay to a distance of 200 yards. This pipe will pass under the Great Western Railway, through the sluice already formed there, at the foot of St. Mary's Lane. The pipe to be laid in a channel excavated in the bed of the Bay, surrounded and protected from the water, during the process of laying, by Coffer Dams of narrow width, and in such lengths as shall be found the most convenient to manage; the water being pumped out by a small portable

Engine. The pipe will be protected by a covering of shingle and large stones, deposited over it after being laid in its place. The extreme end of the pipe to be terminated by a Perforated Iron Screen. The water passing through this pipe will fall into the well just descrided, and will from thence be conveyed by a brick-built Culvert, into the Suction Well within the Engine House.

In submitting to the consideration of the Council, this plan for supplying the City of Hamilton with water from the source specified in the advertisement, I would beg permission to direct attention to the essential requisites for completeness and efficiency which it has been my object to secure. In the first place, looking at the probable rate of increase in the population, my estimate for the supply has been based on double the present number of inhabitants; and in order that the supply may be ample for public as well as private purposes, the allowance per head has been taken at the maximum. In the second place, to secure as nearly as may be an uninterrupted supply, and to provide as far as practicable against those accidents and contingencies which are inseparable from the system of pumping from the lowest level, I have not only deemed it necessary to put down two Steam Engines and two sets of pumps, but also to have each Engine of sufficient power to perform the needful work alone—working the Engines alternately and regularly, and so having one Engine and a set of pumps always in perfect order, and in reserve for any emergency that may arise. In the third place, I have so laid out all the Distributing Pipes as to secure as complete and continuous *circulation* of the water as possible, knowing that without this provision the quality of the water is often much deteriorated at the lower points, and that both in England and America, many otherwise well-designed works of Water-Supply have been marred in effectiveness by the omission of this preventative. In the fourth place, I have anxiously endeavored to make full provision for cleansing and repairs, for an abundant supply of fire-plugs easily reached and readily managed, for flushing sewers, street watering, and for all other public purposes. And lastly, I have had such a careful regard to the outlay as is consistent with that durability and completeness which, in all Public Works, and more especially in works of this description and importance, it is the truest economy to make the first consideration.

SPECIFICATION

Of Work to be done and Materials furnished in erecting Reservoirs, Engines, Pumps, and other Apparatus for supplying the City of Hamilton with Water from Burlington Bay, in accordance with the Plans herewith submitted, and bearing the Motto "NON QUO, SED QUO MODO."

The Area of the Reservoir is to be brought to a uniform and fair level, the earth taken from the heights thereon to be used in filling up the depressions of the surface, to be well rammed and consolidated in layers of not more than 18 inches thick before the retaining embankments are begun. The Embankments to be formed agreeably to the Plan and Section herewith exhibited; the outer slope to be formed to an inclination of one and a half to one; the inner slope to two to one; the Embankments to be 22 feet 6 inches high from the level of the brick bottom of the Reservoir; the outer Embankments to be 10 feet wide on the top; the central one 6 feet wide, to be formed to the entire width in layers of not more than 18 inches thick, of clay or loam of a retentive quality, well worked and beaten together and thoroughly consolidated before the next layer be commenced; the side slopes to be neatly dressed off to the inclination mentioned above, but not till the whole embankment has been completed. Before the Embankments are commenced, the trenches for pipes, foundations for delivery and cleansing wells, and for Valve Houses, to be dug out to the depths and dimensions shown in the Drawings. A wall of puddled clay, 3 feet thick, to be formed in the centre of each Embankment, descending 4 feet below the bottom of Reservoir and carried up to within one foot of the top of the embankments, to be formed of a clay loam mixed with a suitable proportion of fine gravel, the whole well incorporated together and laid on in courses 12 inches thick, well wetted and cut through vertically with spades every $\frac{1}{4}$ of an inch till the whole is rendered compact and water-tight. When one course is set another should be immediately commenced, and during any interruptions of the work the last course to be covered with earth or wet straw to prevent cracking. The bottom of each Reservoir to be formed with a slight inclination towards the cleansing wells shown in the plan, and a shallow open paved Brick Drain laid as shown; the inner slope and bottom to be coated with concrete, formed in the manner hereinafter described, and to be paved with hard burnt clinker bricks laid on edge, and grouted between the joints with liquid mortar, composed of Hydraulic Lime and clean sharp sand in proper proportions.

The Cleansing and Receiving Wells, the Pipes, Foundations of

Valve Houses, and all other portions of the work in which Concrete is exhibited in the Plans and Sections, to be laid and surrounded with Concrete made in the following manner:—The Concrete to be composed of unscreened ballast or gravel, (to be first approved of by the Engineer,) six parts, and of fresh well-burned stone lime, one part; the lime to be beaten or ground to powder on the premises whilst unslacked, the gravel and lime to be then thoroughly mixed in the proportions mentioned above, and in small quantities at a time, the lime at mixing being slacked with as little water as possible, and the concreted mass immediately after mixing to be thrown or dropped from a staging (constructed by the contractor) so as to fall into the trench provided for its reception from a height of at least 12 feet; the layer of concrete to be of such thickness as the Engineer shall direct, and extending the whole width of the trench, and to be well rammed before any masonry is laid upon it. The Receiving, Delivery and Cleansing Well, Valve House and Stand-Pipe Tower, and all other masonry connected with the Reservoir, will be built of the dimensions and forms as shewn in the respective Drawings of the same. And all the exposed portions of such work to be built of regular coarse masonry, the beds and joints to be dressed perfectly true, both vertically and horizontally, and closely set; the stones, in all cases, to be laid on their natural beds with alternate headers and stretchers, the beds to be not less than 12 inches wide, and the courses not less than 12 inches high—the headers to be at the very least 1 foot 8 inches long. Those portions of the work shown as rock-faced masonry, including the pilasters, window jams, arches and quoins of Valve House, to be of the best free-stone, with a tooled draft of 1½ inch wide to all joints and projecting arris. The whole of the rest of the mason work connected with the Reservoir, and also the Receiving and Cleansing Wells and Sluice Cock Wells, to be finished in a neat and regular course, hammer-dressed to a fair surface, and the joints to be close and true both vertically and horizontally. All this work to be backed with the best rubble masonry, of large flat stones laid on their natural beds, and the whole properly laid and bedded in mortar, compounded of one-third well burnt stone lime, and two-thirds of clean sharp sand, well beaten and carefully amalgamated The parapet, cornice, mouldings, plinth, window and door sills of Valve House to be of free-stone walling, tooled on the exposed surfaces—the beds and joints as before described—the door sills to be 12 × 8, and the window sills 12 × 6.

The masonry of the Engine House and Stand-pipe Tower to be executed in the manner herein above described, and in strict accordance with the drawings of the same; such portions as are not shown in rock masonry are to be executed in tooled ashlar masonry. The

main shaft of Stand-pipe Tower, the flues, circular shaft of Engine Chimney, and all other work shown in brick, to be built of the best hard-burnt stock bricks—as also the brick casing round the Boilers, Ash-pit, &c.

A Well to be sunk in the position shown in the enlarged Map, for receiving the water from the Pipe into the Bay, will be built of hard bricks laid in Hydraulic Cement on a Cast Iron Curb, with a cutting edge downwards, the soil to be taken out from the interior, and as the Curb sinks the brick sides to be carried up in proportion—the brick to be moulded so as to radiate from the centre of the curve, and to be laid in heading courses two bricks (18 inches) thick. The Well to be sunk to the depth of 25 feet below the ground level: proper openings to be left in the side nearest the Bay, for the insertion of the cast iron Inlet Pipe. The back of the Well to be properly puddled. An arched Brick Culvert to be carried from the Well to the Suction Well of the Engine House.

Engines, Pumps, &c.

The Engines and Pumps to be constructed in strict accordance with the several Drawings thereof annexed, and as hereinafter more particularly specified, viz: *The Cylinder* of each Engine to be 22½ inches dameter, having a stroke of 5 feet; to be of fine hard cast iron and accurately bored and fitted in all respects; the cylinder cover and valve spindle-gland to be bushed with fine hard gun metal, and also the bottoms of the stuffing boxes. *The Piston* to be fitted accurately with two brass rings, which are to be acted upon by hemp in the inside of the same by means of a plate and screws. *The Piston Rod* to be of the best faggotted Wrought Iron, and properly fitted into the cross head, and secured by a colter. *The Beam* to be made as per detail Drawings, having the main and smaller gudgeons truly turned and fitted. *The Air Pump* to be of fine hard cast iron, and truly bored and fitted with a piston of the same description as the piston in the Steam Cylinder, and the bushes and glands to be of the same description as those in the Steam Cylinder. *The Air Pump Rod* to be accurately fitted into the gland of the Air Pump lever and attached to the back links of the motion. *The Condenser* to be cylindrical, and of the dimensions and form shown in the drawings, the joints to be all accurately faced and properly furnished with bolts and nuts. *The Injection Cock* to be made of brass, and fastened to the Condenser by means of a flange bolted to the side of the same, and to be provided with a spindle and handle for regulating the supply of Injection Water. *Hot Water Pump* to be of brass, and of the form and dimensions shown in the Drawings, fitted with strong conical valves and all the necessary pipes for suction and delivery; the ram to be of iron, truly bored, and having a rod jointed to the same and attached to the working beam. *The Cold Water Pump* to be made of the finest cast iron, as hard as that of the Cylinder, and fitted with a plunger truly turned, and connected to a rod, and to be worked by the working beam, at the distance shewn in the Drawings. *The Crank* to be of tough cast iron, the eye to be truly bored and fitted into the

crank shaft and secured to the same by two strong keys, and not to be shrunk on to the shaft; the crank pin to be truly turned to the dimensions shown on the Drawing, and to be well fitted into the crank, and fastened by means of a colter through the crank and pin. *The Crank Shaft* to be of cast iron, truly turned as per Drawing, having its journals in the position and of the dimensions shown in the Drawing —to be accurately observed. *The Connecting Rod* to be of cast iron, and of the form shown in the Drawings; the small ends to be fitted with continuous straps, with the necessary brasses, pins and colters, all properly fitted; the large or crank end to be solid, having a pin slotted out and brasses truly bored and fitted into the same, and to be acted upon by the colter. *The Fly Wheel* to be 20 feet in diameter, having a section of its ring not less than 28 inches, and not to have less than six arms; to be cast in three pieces and secured at the nave by two wrought iron rings shrunk on to the same; the ring to be fastened by wrought iron straps shrunk on two pieces formed on the same for this purpose, and bolts to pass through the whole, thus securing the ring on both sides—a Drawing hereafter to be furnished. *The Eccentric Pully* to be of cast iron, and having the throw accurately secured according to the Drawing—to be properly bored out and keyed on to the shaft. *The Eccentric Strap* to be of brass, very hard with babbit metal, and fastened together with two nuts and bolts, and of the form shown in the Drawing, with the Eccentric Rod attached. *The Weigh Shaft* to be wrought iron, truly set out and finished, having the startling line and balance-weight of the dimensions shown on the Drawing. *The Slide Valve* to be a long D Valve, leaving the amount of lap shown on the Drawing—to be truly fitted and scraped to a proper surface, and to be cast of fine cast iron, not too hard, to be worked by two good side rods with solid ends fitted with brasses and colters, and attached to a cross head of wrought iron, and the same to be fitted to the valve spindle, which is to have nuts on either side of the same for the purpose of adjusting the travel of the Valve. *The Columns* for supporting the girders to be of the dimensions and form shown in the Drawings, and to be firmly fastened to the transverse plate built into the formation of the Engine Room. *The Girders* to be of the section shown, and fastened to the columns by four bolts; the longitudinal girders to have cheeks and chipping pieces cast on them, so as to be able to get up a true bed for the Plummer Blocks for carrying the main beam gudgeons. *The Plummer Blocks* to be of the form and dimensions shown—to be very accurately fitted in every respect, and the brasses to be of good tough gun-metal lined with babbit metal, and fitted with suitable lubricators. *The Parallel Motions*—The main links to be of the form and dimensions shown, fitted with hard gun-metal brasses, accurately bored, with distance pieces, gibs and colters complete; the back links to be open-ended, having hard gun-metal brasses with distance pieces and keys well fitted; the parallel bars to be round, larger in the centre than at the ends, and of the dimension shown in the Drawings—they are not to have straps, but to be fitted with brasses and keys, with cups for lubricating the working parts: the Radius Rods to be of the same form, very accurately centred. *A Blow-through Valve* to be provided and put in a convenient part for the Engineman to use with the levers of the start-

ing gear. *The Large Pump* to have a Cylinder 17 inches in diameter and a stroke of three feet, with an air vessel to each, a drawing of which will be furnished hereafter: the Cylinder to be of good hard cast iron, very accurately bored and fitted, with a piston of the same description as that described for the Cylinder of the Engine; the Cylinder to be 1¾ inches thick, to be fitted with Valve Boxes and Valves; the Valves to be of leather, with a thickness of vulcanized India Rubber at the back of the Ram, the two being drawn together by bolts passing through two iron plates; the Valves to work upon metallic hinges, and this description of Valve to be employed in all parts of this pump, a detail drawing of which will hereafter be furnished: the Valves must have checks fastened on the inside of the Valve Boxes, and so placed that the Valve shall not open too far; all the joints to be very truly faced, and the Valve Doors to be planed on the joint surface and well bolted to the Valve Box; the Piston Rod to be 3⅛ inches thick, of the very best faggoted wrought iron. *The Pump Cover* to be well fitted to the pump flange, and thoroughly bolted down; it must have brass bushes and glands. A set of open Valves are also to be provided; all the other parts of the same to be as per Drawing, well bedded down to the bed plate which is to carry both this and the Cold Water Pump. The Piston to be worked by a rod attached to a parallel motion before described, and worked by the large beam. *The Boilers* are to be tubular, and four in number, having an internal Fire Box of the form shown in the Drawings, the thickness of which is ½ inch; the outer shell of the Boiler is to be ⅜ thick, and well rivetted together by ¾ rivets 1½ pitch; the tube plate near the Fire Box to be 1¼ inch thick, the one at the Smoke Box to be 1 inch, the front plate ¾ thick—the Smoke Box to be of ¼ sheet iron, of the dimensions and form shown, and fitted with a door inside —the *Tubes* to be not less than 56 in number, of 3 inches external diameter, and 6 feet 6 inches long—they are to be of the best patent lap-welded iron tubing, proved to a pressure of 150 lbs. by Steam, or 200 lbs. by Hydraulic pressure, and fastened into the Fire Box tube plate by steel ferrules, which are to be truly turned, slightly tapered, and the holes in the tube plates to be bored to the same. *The Stays* on the top of the Fire Box are to be arranged as shown and ½ inch thick; each Boiler to be provided with two mud plugs and one 2-inch blow-off cock, and a spare set of fire bars—also, on one side a set of brass guage cocks, and on the other with a glass water guage. *Safety Valves.*—On the Steam Dome there must be two Safety Valves, and a regulator for stopping the communication between any of the Boilers, detail drawings of which will hereafter be given; one of the Safety Valves is to be provided with a weight, and the other with a Spring Balance; and in addition to this each Boiler is to have a float apparatus for testing the height of the water in the Boilers, in the event of the other means failing by damage or other defects. *The Steam Pipes* are to be ½ inch thick, provided with expansion joints, and well clothed, so as to be protected from the effect of cold, which would very much diminish the effect of the steam in its passage to the Boiler; all the flanges are to be provided with 1-inch nuts and bolts; the pipes to be 6 inches diameter inside. The Engines, Pumps and Boilers described in this Specification, to be thoroughly completed in a perfectly workmanlike manner in every respect, all the usual parts

to be bright; and all Patterns and Castings to be submitted for inspection by the Engineer appointed for that purpose by the City Council. And it is further to be understood, that all details not herein mentioned, but shown upon the Drawings or otherwise intended to be specified, and actually necessary to be made, are to be undertaken, with any slight alterations that may hereafter be decided upon for the best by the party or parties contracting or otherwise undertaking the said works—the same to be completed and set at work at the expense of the said Contractors on the place appointed for the erection of the said Engines, Pumps and Boilers.

AN ESTIMATE

Of the Cost of the Works herein reported upon, and to be executed in accordance with the Drawings and Plans herewith submitted, and bearing the motto, "NON QUO, SED QUOMODO."

	£	s.	d.
Reservoir, Land and Appendages	2,500	0	0
Two 35 Horse-Power Engines, with Boilers, Pumps, &c.	6,000	0	0
Main Pipes, and Laying	25,000	0	0
Sub-main and Service Pipes	30,000	0	0
Engine House, Tower, Wells, &c	2,500	0	0
	£66,000	0	0

This Estimate is for the supply of the whole area of the City, and the entire works as delineated on the Plans, but as the greater portion of the above amount would be expended in laying the pipes through districts, where, from the sparseness of the population, a supply of water will not presently be needed, the amount is of course very much above that required for the immediate necessities of the City. By confining the supply to the more central portion of the City, this amount may be very greatly diminished. My Estimate for the Mains, Sub-mains, and Service Pipes to supply the area bounded on the south by Hannah street, on the north by Stuart street, the west by McNab street, and the east by Wellington street, including the Reservoir, Engines, Stand Pipe, Hydrants at the intersection of every street, and all the necessary appendages, is £26,400 0 0

It is also right to state that although the use of the Stand Pipe is expedient and desirable, yet it is not absolutely necessary, the cost therefore (£950) may be deducted from this amount, thus making the sum £25,450 0 0

WILLIAM HODGINS,
City Engineer,
Hamilton, C. W.

November 10, 1854.

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